

UNCLASSIFIED

AD NUMBER

AD492958

NEW LIMITATION CHANGE

TO

Approved for public release, distribution  
unlimited

FROM

Distribution authorized to U.S. Gov't.  
agencies and their contractors;  
Administrative/Operational use; 3 Dec  
1934. Other requests shall be referred to  
Naval Research Lab, Washington DC.

AUTHORITY

USNRL ltr, 14 May 1971

THIS PAGE IS UNCLASSIFIED

**UNCLASSIFIED**

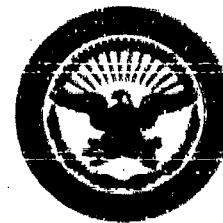
**AD. 492958**

**DEFENSE DOCUMENTATION CENTER**

**FOR**

**SCIENTIFIC AND TECHNICAL INFORMATION**

**CAMERON STATION ALEXANDRIA, VIRGINIA**



**UNCLASSIFIED**

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

Tests on Mercury-in-Glass Thermometers

N. Eng. 70-C

X - 1 6 3 2 1

492950

## REPORT NO. R-1099

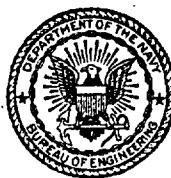
DATE 3 December 1934

### SUBJECT

Tests on Mercury-in-Glass Thermostats

567/49/15 12-3

105A



BY

NAVAL RESEARCH LABORATORY

BELLEVUE, D. C.

## **DISCLAIMER NOTICE**

**THIS DOCUMENT IS BEST QUALITY  
PRACTICABLE. THE COPY FURNISHED  
TO DTIC CONTAINED A SIGNIFICANT  
NUMBER OF PAGES WHICH DO NOT  
REPRODUCE LEGIBLY.**

COPY FOR LT. GOULETT

MIS/5  
J-Z-8-7-hl

567/40 (10-26-56)

NAVY DEPARTMENT  
BUREAU OF ENGINEERING  
Washington, D.C.

out 9 Oct

From: Bureau of Engineering,  
To: Director, Naval Research Laboratory, Anacostia, D.C. OCT 20 1956

Subject: Radio - Test of thermometers submitted by Taylor Instrument Companies - Bu.Eng. Problem M18-5.

Reference: (u), NRD, Anacostia letter 567/40/15 of 18 September, 1956 to Bu.Eng.

1. It is requested that the subject sample thermometers be returned to the Taylor Instrument Companies, Rochester, N.Y., marked for the attention of Mr. Lingg, at their expense.

As above  
by direction

M18-5



J-Z-8-7-m

367/40/L5 (S-14-38) 1st Endorsement.

JUN 11 1935

From: Bureau of Engineering.  
To: Director, Naval Research Laboratory, Anacostia, D.C.

Subject: Radio - Request for test of Thermocouple - Precision Thermometer and Instrument Co. (New York Navy Yard N.Y.A.P. Regn. 1-2084).

Reference: (a) N.R.L. Anacostia, ltr 367/40(1) of 14 June 1935, to BuEng.

Information: (a) Comdt. New York ltr R-1-2084(I-11) of 13 June 1935, with copy of subject Regn., to N.R.L.

1. Returned, requesting that the thermocouple be subjected to routine tests in accordance with specifications R-13-1-4663, under Bureau Engineering problem M18-5.

A. J. Rubin  
By direction

Re: to:

Naval Research Laboratory, Anacostia, D.C.

July 23, 1955

U. S. Navy Research Laboratory  
Anacostia  
B. C.

Attention Mr. R. B. Owens

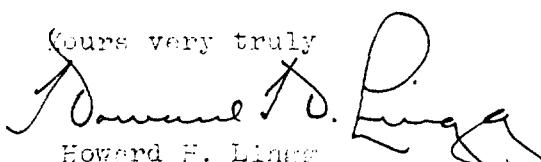
Dear Mr. Owens

Ten pieces sample thermostat for test under specification RE 13A486B are being shipped to your personal attention from our factory today.

This shipment is made in accordance with the arrangement negotiated on the writer's recent visit to your laboratories.

We would appreciate very much your report after completing tests on these instruments.

Yours very truly

  
Howard F. Linge  
Industrial Sales Department

R.F.

*Conrad J. W. Smith ✓*

N. Eng. 5a  
ADDRESS BUREAU OF ENGINEERING, NAVY DEPARTMENT

AND REFER TO NO. **SEV/49/LB (8-10-WB)**

*J. Z. S.*

ENCLOSURES

NAVY DEPARTMENT  
BUREAU OF ENGINEERING  
WASHINGTON, D. C.

*M.W.*  
Gentlemen:

The Bureau is authorizing the return of the ten sample thermostats submitted to the Naval Research Laboratory for test under specifications RG-154-484B, upon completion of such tests, as requested by your letter of 10 August.

Test data will be forwarded to you when available subject to the understanding that it will not be used for advertising purposes.

Very respectfully,

- - -

Taylor Instrument Companies,  
1734 Lincoln-Liberty Bldg.,  
Philadelphia, Pa.

Attention: Mr. W. W. Taylor.

REPLY IN DUPLICATE  
AND REFERENCE TO

**867/40**  
WILL BE APPRECIATED

NAVAL RESEARCH LABORATORY

ANACOSTIA STATION  
WASHINGTON, D. C.

REO:LP

26 August 1935.

From: Director.  
To: The Chief of the Bureau of Engineering.  
Subject: Radio - Report of test of thermostats  
submitted by the Taylor Instrument Companies.  
(BuEng.Prob.M18-5)

Reference: (a) BuEng let.S67/40(10-25-W8) of 27 Oct.1934.

Enclosure: (A) 5 copies of NRL Report No. R-1183.  
s/c

1. There are being forwarded 5 copies of NRL Report  
No. R-1183 on Test of Thermostats submitted by the Taylor  
Instrument Companies. These tests were authorized by ref.(a).

2. It is requested that shipment orders be issued  
this Laboratory so that the thermostats may be returned to  
the manufacturer.

H. M. Cooley

S67/40/L5 (8-10-W8)

✓ 8-Z-8-m

FROM: Bureau of Engineering.  
TO: Director, Naval Research Laboratory, Anacostia, D.C.  
Subject: Radio - Bu. Eng. Problem M18-5.

1. It is requested that the ten sample thermostats submitted by the Taylor Instrument Companies for test under specifications RE-15A-486B be returned to them at Rochester, N.Y., marked for the attention of Mr. H. H. Lingg, upon completion of tests under the subject problem.

\* J. Huble  
By direction.

N. Eng. 5a

ADDRESS BUREAU OF ENGINEERING, NAVY DEPARTMENT

AND REFER TO NO. S67/40/L5 (8-10-W8)

ENCLOSURES

NAVY DEPARTMENT  
BUREAU OF ENGINEERING  
WASHINGTON, D. C.

7-11-55

FROM: Bureau of Engineering.  
To: Director, Naval Research Laboratory, Anacostia, D.C.  
Subject: Radio - Bu. Eng. Problem M18-5.

1. It is requested that the ten sample thermostats submitted by the Taylor Instrument Companies for test under specifications RE-13A-486B be returned to them at Rochester, N.Y., marked for the attention of Mr. H. H. Lingg, upon completion of tests under the subject problem.

W J Ruble  
By direction.

*M18-5*

N. Eng. 5a

ADDRESS BUREAU OF ENGINEERING, NAVY DEPARTMENT  
AND REFER TO NO. S67/40/L5 (8-26-78)

ENCLOSURES

(1)

NAVY DEPARTMENT

BUREAU OF ENGINEERING

WASHINGTON, D.C.

*Out 4 Sept '35*

Gentlemen:

The Bureau is forwarding herewith a report of the test of the sample thermostats submitted for examination under specification RE-13A-486B subject to the understanding that it will not be used for advertising purposes.

Very respectfully,

---

Taylor Instrument Companies,  
1734 Lincoln-Liberty Building,  
Philadelphia, Pa.

Attention: Mr. E. C. Taylor.

M18-5

N. Eng. 5a

ADDRESS BUREAU OF ENGINEERING, NAVY DEPARTMENT  
AND REFER TO NO.

867/40/L5 (8-10-88)

Z-J-S-T-m

NAVY DEPARTMENT

BUREAU OF ENGINEERING

WASHINGTON, D. C.

ENCLOSURES

From: Bureau of Engineering.  
To: Director, Naval Research Laboratory, Washington, D. C.  
Subject: Radio - Report of Test of Thermostats submitted by  
the Taylor Instrument Companies. (Bu. Eng. Problem  
M18-5).  
Reference: (a) N. R. I. Incoastia ltr 87/40 or 23 Aug. 1938  
to Bueng.  
(b) N. R. I. Report No. R-1103.  
(c) Bueng ltr 867/40/L5 (8-10-88) of 27 Aug. 1938,  
to N. R. I. Incoastia.

1. It is requested that the ten sample Taylor thermostats, which have been reported upon in reference (b), be returned to the Taylor Instrument Company, Rochester, N.Y., at the letter's expense. The shipment should be marked "attention of Mr. . . . Lines".

JZ-8-7-h1

267/40 (10-25-48)

9 - OCT 1935

From: Bureau of Engineering,  
To: Director, Naval Research Laboratory, Anacostia, D.C.

Subject: Radio - Test of thermometers submitted by Taylor Instrument Companies - Bu.Eng. Problem Y18-5.

Reference: (by Nal., Anacostia letter 267/40/18 of 16 September, 1935 to Bu.Eng.

1. It is requested that the subject sample thermometers be returned to the Taylor Instrument Companies, Rochester, N.Y., marked for the attention of Mr. Lingg, at their expense.

J. J. Auble  
By direction

M18-5

J-Z-8-m

567/40 (11-21-WB)

X---NOS-38614

20 NOV 1955

From: Bureau of Engineering.

To: Director, Naval Research Laboratory, Anacostia, D.C.

Subject: Radio - Thermometers - Bureau of Engineering  
Problem No. M18-5.

Enclosure: (A) Two copies of specifications NK-13A-406C. (b.w.)  
(B) Two thermometers, Type 213-40014. (s.c.)

1. It is requested that the enclosed thermometers be tested to determine compliance with the "B" and "C" revisions of specifications NK-13A-406 under the authority of the subject problem.

2. A report in the premises is requested by 7 December.

J. J. Public  
By direction.

M18-5

Z-J-8-m

567/74 (3-2-58)

1 MAR 1936

From: Bureau of Engineering.  
To: Director, Naval Research Laboratory, Anacostia, D.C.  
Subject: Radio - Wekeler Thermometer Corp. - Thermometer and  
Thermostat (Bureau of Air Commerce) - Test of -  
(Bureau of Engineering Problem M18-5).

Reference: (a) Bueng Specifications RG 13A 486E, dated  
17 Feb., 1934.

1. It is requested that the subject thermometer and thermostat, forwarded to the Laboratory by the Bureau on 2 March, 1936, be tested to determine compliance with reference (a); and that a report be submitted in the premises.

W. J. Rabb  
Director

- - -

*M18-5*

SCL7 (2-25-#8)

*WPA*

2-J-8-m

4 MAR 1936

Sir:

In reply to your letter of 25 February, 1936, regarding proposed tests of the WEMCOER Thermometer Corporation mercury angle thermometer and mercury thermostat at the Naval Research Laboratory, you are informed that the Bureau has initiated action to have the desired tests made as requested, in order to determine compliance of this material with specification NC-13A-486B.

A report of these tests will be forwarded to your office as soon as it is available in the Bureau.

Very respectfully,

*S. J. Hopkins  
by direction*

Mr. Rex Martin,  
Assistant Director of Air Commerce,  
(Air Navigation),  
Department of Commerce,  
Washington, D.C.

EC17 (2-25-W8)

WBF  
7-8-31

22 APR 1936

sir:

The WENGER Thermometer Corporation mercury angle thermometer and mercury thermostat, discussed in your letter of 25 February, and in the Bureau's letter of 4 March, 1936, have been tested at the Naval Research Laboratory, Anacostia, D.C., to determine compliance with Bureau of Engineering specification BE-13A-436B.

The thermometer was found to comply with the above specification, so far as could be determined, except as to the minor details of length, temperature range, and scale gradations. The calibration of the thermometer is accurate to within the required limit of .1 degree C. This instrument withstood an acceleration of 56 g. in the shock test without separation of the mercury column. The mercury column was separated when received at the laboratory, but was easily joined by heating. The expansion chamber of the thermometer affords protection up to 100 degrees C., and at -10 degrees C. the mercury does not contract into the bulb but extends one and three-quarters inches above it. The dimensions of the thermometer do not comply with the above specification, but are as follows:

Length of bulb portion,	.5-1/16"
Length of scale portion,	4-1/2"
Diameter of the scale portion through the bevel,	.274"

The thermostat failed to comply with paragraphs 8-10, 4-3, 4-4, and 4-6 of the above specification, with respect to accuracy of operating temperature, sensitivity, effect of shock, and life test. The thermostat had an operating temperature of approximately 49.89° C. This is stated as an approximation since the temperatures at which the thermostat opened and closed the circuit differed considerably. The average temperature difference between the make and the break was .10° C. and the extreme difference was .16° C. In other words, the sensitivity of the instrument was approximately .10° C. instead of .03° C. as required by para. 4-4 of the specification. Many thermostats tested at the laboratory make and break contact within .01° C. of the same temperature.

SC17 (2-25-58)

The expansion chamber of the thermostat protects the instrument to 100° C., and the mercury was more than 1" above the bulb at -10° C.

In the shock test, the mercury column of the thermostat separated at an acceleration of 39 g, whereas the specification requires that the instrument withstand 50 g. without separation. At an acceleration of 39 g. the mercury from a 1" length of the capillary was separated and a portion of it was thrown into the expansion chamber. In the life test, the walls of the capillary of the thermostat were blackened or coated with particles of mercury for a distance of about 1/4" below the upper contact ring after the instrument had made not more than 120,000 contacts. After 175,000 contact cycles, a large number of minute shiny particles adhered to the glass between the contact rings, and the operating temperature was now about 1° low.

The Bureau will return the two instruments to your office, under separate cover.

Very respectfully,

E. J. Eubank  
by direction

Mr. Rex Martin,  
Assistant Director of Air Commerce,  
(Air Navigation),  
Department of Commerce,  
Washington, D. C.

**MPL4/BS (938)**

NAVY DEPARTMENT  
BUREAU OF SHIPS  
WASHINGTON, D.C.

**938-932-81**

*11/25/42*

*25*

**From:** The Chief of the Bureau of Ships.  
**To:** The Director, Naval Research Laboratory, Anacostia, D.C.  
**Subject:** Radio - Bureau of Ships Problems, Closing of.

**Reference:**

- (a) BuShips conf. ltr. C-MPL4/BS(480b) of Aug. 16, 1942 to NRL.  
(b) NRL Quarterly Progress Report C-A9-4/EM8 of Nov. 10, 1942.

1. The following problems, having been completed and reported, are hereby closed:

<u>Problem No.</u>	<u>NRL Report</u>
M3-36 . Test Hardwick-Hindle resistors (Sample Group #1).	R-1913 of 7/28/42
M3-38 Test Hardwick-Hindle resistors (Sample Group #2).	R-1947 of 10/14/42
M18-5 Test thermometers and thermo- stats.	R-1881 of 6/1/42
M35 Test salt spray on electro-zinc cord holders.	S67/49(341-HAB) of 9/8/42.
M44 Test 3 sockets for Navy Type 19018 battery pack.	S67/19(341:HAB) of 9/29/42.
M49 Test anti-corona adapter cap for pedestal insulators (Majes- tic.)	S67/61(380-RBQ) of 10/13/42.

*mis*  
*Pentate Prob file*  
480 b  
S67/40(480V)

Vn-Xa-480b-480-pjf

6-26-42

From: The Chief of the Bureau of Ships.  
To: Electric Glass Company, Hatboro, Penna. JUN 27 1942  
VIA: INSPECTOR OF NAVAL MATERIAL, PHILADELPHIA.  
SUBJECT: Radio - Thermometers and Thermostats - Electric  
Glass Company, Manufacturer - Forwarding of  
Final Report.

Reference:

- (a) BuShips Problem ltr S67/40(480V) of Nov. 14, 1941 to NRL.
- (b) BuShips ltr S67/40 of Mar. 4, 1942 to Electric Glass Co.  
via INSMAT, Phila.
- (c) BuShips ltr S67/40(480V) of May 27, 1942 to Electric  
Glass Co. via INSMAT, Phila.
- (d) Spec. RE 13A 486C.
- (e) NRL Report R-1881.

Enclosure:

- (A) One copy of ref. (e).

1. The Bureau hereby forwards as enclosure (A), the  
final report on the test of thermometers and thermostats manu-  
factured by the Electric Glass Company, Hatboro, Penna. for  
your information and file.

2. The manufacturer's attention is called to the com-  
ments on the method of securing leads to the thermostat mount-  
ing rings, reference (e). These should be so soldered as to be  
easily removed.

3. The use of General Electric Flamenol wire, as author-  
ized in reference (b) paragraph 3, is believed to rectify the  
condition of stiff leads existing on the test samples.

4. The artificial high rating of cycling, necessary in  
testing the thermostats in the time available for such test,  
caused apparent failures of several of the thermostat samples,  
but the Bureau concur with the testing laboratory that suffi-  
cient evidence is present to consider the thermostat satis-  
factory under normal rates of cycling and, therefore, the approval  
(e), is hereby confirmed.

S67/40(480V)

- 2 -

5. The thermometers CEG 40014 have satisfactorily met reference (d), and approval, reference (e), is hereby confirmed.

6. The use of the contents of this letter, or of N.R.L. Report R-1881, either in whole or in part, for advertising or publicity purposes, is not authorized.

Copy to: NRL

- - -

A. B. Chamberlain  
By Direction

Problem file

M 18-5

867/40(480-V)

Va-V-X-480b-480-pjf

11-10-41

NOV 14 1941

From: The Chief of the Bureau of Ships  
To: The Director, Naval Research Laboratory,  
Anacostia, D. C.  
SUBJECT: Radio - Thermostats - Electric Glass Company,  
Inc. - Problem M18-5-Priority A.

Reference:

- (a) BuShips ltr. 867/40(480-V) of Oct. 7, 1941 to Electric Glass Co. via INSMAT, Phila. cc NRE.
- (b) Electric Glass Co. ltr. NREK of Nov. 4, 1941 to BuShips.
- (c) BuShips ltr. 867/40(480-V) of Nov. 17, 1941 to Electric Glass Co. via INSMAT, Phila. cc NRE.
- (d) Specification NF 13A 4860.

1. The Bureau desires that qualification tests in accordance with reference (d) be conducted on thermostats to be submitted to the laboratory as of reference (c).

2. Problem M18-5, priority A, now an open problem, is designated for test of the thermostats of Electric Glass Company, Incorporated.

3. Ten copies of the report of the results of the tests are requested. One of these may be forwarded by the Bureau to the manufacturer and any reference to other materials of a similar nature, or other reports, should be confined to a sheet or sheets which may be easily removed from the report.

W. J. Patterson  
Engineering

- - -

FILE COPY  
DO NOT ISSUE

REPLY IN DUPLICATE  
AND REFERENCE TO

887/40 N  
WILL BE APPRECIATED

RETURN TO Problem M 18-5

WEB/np

NAVAL RESEARCH LABORATORY  
ANACOSTIA STATION  
WASHINGTON, D. C.

13 March 1941

From: Director.  
To: Chief of the Bureau of Ships.  
Subject: Thermometers, Resistor, Test of. Bureau of Ships  
Problem M18-5.

Reference: (a) Telephone request from BuShips on 28 February 1941.

1. Two samples of a mercury thermometer submitted by the Philadelphia Thermometer Company designed to measure the temperature of resistors in service, were sent by a representative of the Bureau to the Laboratory with the request that their readings be compared with a thermocouple at a temperature of about 125°C. The following tabulation shows the readings of a calibrated thermocouple and the sample resistors:

	<u>Readings</u>	<u>Differences</u>
<u>Side by side on hot resistor</u>		
Thermocouple	131.5°C.	
Resistor Thermometer #1	136.	+ 4.5
Thermocouple	127.	
Resistor Thermometer #2	129.	+ 2.
<u>Alternately on same spot on hot resistor</u>		
Thermocouple	130.	
Resistor Thermometer #1	134.	+ 4.
Thermocouple	126.	
Resistor Thermometer #2	129.	+ 3.

2. As a matter of information, these resistors were immersed in a hot salt bath with a standard thermometer of high reliability. The readings are shown in the following tabulation. It is to be noted that the resistor thermometer reading was considerably higher than the standard thermometer which indicates that their design contemplated a certain loss in heat transfer when they are attached to a resistor:

13 March 1941

	<u>Readings</u>	<u>Differences</u>
<u>Immersion in salt water</u>		
Standard Thermometer	105.4 °C.	
Resistor Thermometer #1	116.	+ 10.6° C.
Resistor Thermometer #2	116.	+ 10.6

3. Two spring clips were supplied to hold the resistor thermometers on the resistor. In taking these on and off several times one of the spring clips was broken. It appears that the bend at the top was made at too sharp an angle. The clip that broke seemed to be of considerably harder steel than the one that did not break. These thermometers were returned to the Bureau of Ships by messenger on 5 March 1941.

R. P. Briscoe,  
By direction.

667/40/L5 (10-29-48)

W.C.Y.  
J-Z-8-m

1

1 - FEB 1948

Gentlemen:

The Bureau forwards herewith a copy of Naval Research Laboratory Report No. R-1312 covering the test of two each of your thermometers and thermostats for compliance with specifications RE 13A 486B subject to the understanding that this information will not be used for publicity purposes.

The instruments were found to comply with specifications RE 13A 486B in all respects except that the expansion chamber of one of the thermometers failed to protect this instrument at 95°C. and the thermometers were in accordance with the dimensional requirements of drawing RA 40A 225B.

Specification RE 13A 486B has been superseded by specification RE 13A 486C. Consequently, before these instruments can be approved for Naval use under current specifications it will be necessary for you to submit a sample thermometer and thermostat suitable for demonstrating compliance with the latest specification and showing that the reported slight deficiency in the thermometer expansion chamber has been corrected.

Very respectfully,

Taylor Instrument Companies,  
Colorado Building,  
17th and G Sts., N.W.,  
Washington, D.C.

Attention: Mr. Price.

ACCELERATION OF 65 g IN THE SHOCK TEST.

S67/40/L5 (8-3-W8)

W.S.  
Z-J-8-m

<sup>1</sup>  
(S.C.)

14 NOV 1936

Sir:

The two thermometers and the two thermostats (Taylor Instrument Company) recently tested at the Naval Research Laboratory, Anacostia, D.C., are being returned under separate cover. The results of the tests are discussed in the Bureau's letter of 4 November, 1936.

The bulb of thermometer No. 7A852907 broke at a temperature of 95 degrees C. in the test to determine whether the capacity of the expansion chamber was sufficient to protect the instruments up to 100 degrees C.

The separation of the mercury column in thermostat No. 7A935962 occurred when the instrument was subjected to an acceleration of 65 g in the shock test.

Very respectfully,

- - -

Mr. Alex Martin,  
Asst. Director of Air Commerce (Air Navigation),  
Department of Commerce,  
Washington, D.C.

REPLY IN DUPLICATE  
AND REFERENCE TO  
**567/40**  
WILL BE APPRECIATED

NAVAL RESEARCH LABORATORY

ANACOSTIA STATION

WASHINGTON, D.C.

RBO/ejh

9 November 1938

From: The Director.  
To: The Chief of the Bureau of Engineering.  
Subject: Radio - Taylor Instrument Company Thermometers  
and Thermostats - Return of test samples  
(BuEng.Prob. M18-5).  
Reference: (a) BuEng.ltr. 567/40/L5(8-3-W8) of 4 Nov.1938.  
(b) NRL Report No. R-1312.  
Enclosure: (A) Two thermometers and two thermostats.  
s/c

1. As requested in reference (a), the two thermometers (Nos. 7A852907 and 7A852912) and the two thermostats (Nos. 7A935962 and 7A935963) reported upon in reference (b) are being returned to the Bureau under separate cover.

2. The bulb of thermometer No. 7A852907 broke at a temperature of 95 degrees Centigrade in the test to determine whether the capacity of the expansion chamber was sufficient to protect the instruments up to 100 degrees Centigrade.

3. The separation of the mercury column in thermostat No. 7A935962 occurred when the instrument was subjected to an acceleration of 65 g in the shock test.

H.M. Cooley.

M18-5

W.H.  
21K-8-m

867/40/L5 (6-20-38)

7 - NOV 1936

Gentlemen:

Tests of the six thermometers mentioned in your letter of 20 June, 1936, and in the Bureau's letters of 14 August and of 30 October, 1936, have been completed at the Naval Research Laboratory, Anacostia, D.C.

The results of tests show that both of the groups of thermometers comply with Bureau of Engineering Drawing BB 40A 123B with respect to dimensions; and, so far as could be determined, conform with the requirements of Bureau of Engineering Specification BB 13A 426C in all other respects. The thermometers are therefore considered suitable for Naval use.

It is understood that the information given herein will not be used for advertising purposes.

Very respectfully,

The Prineer Company,  
Cincinnati (St. Bernard),  
Ohio.

Attest: John W. A. Mongigian.

7 Nov., 1936.

J:

In connection with the Palmer Company's tests (see attached), Lt. Comdr. Bruner (Ds) came over to see whether or not we desire to have this company placed on the APPROVED LIST. He stated that likely the company will want its name on the list because of the results of these tests, and may send in a letter to this effect.

If we desire to have the Palmer Co. on the approved list, apparently we should have W-7 write to BUSUNDA or else arrange with Ds to have that Section notify BUSUNDA. In any event Ds should know.

Resp.,

Z.

*H. M. Stone*

*M18-5*

*469*  
*C-A-8-a*

N. Eng. 5a

ADDRESS BUREAU OF ENGINEERING, NAVY DEPARTMENT

AND REFER TO NO.

**S67/40/L5 (6-20-48)**

NAVY DEPARTMENT  
BUREAU OF ENGINEERING

ENCLOSURES

WASHINGTON, D. C.

*11/4/36*  
*Out 7 Nov. '36*

Gentlemen:

Tests of the six thermometers mentioned in your letter of 20 June, 1936, and in the Bureau's letters of 14 August and of 30 October, 1936, have been completed at the Naval Research Laboratory, Anacostia, D.C.

The results of tests show that both of the groups of thermometers comply with Bureau of Engineering Drawing N. 40A 1028 with respect to dimensions; and, so far as could be determined, conform with the requirements of Bureau of Engineering Specification RR 13A 4260 in all other respects. The thermometers are therefore considered suitable for Naval use.

It is understood that the information given herein will not be used for advertising purposes.

Very respectfully,

W. J. R.

The Palmer Company,  
Cincinnati (St. Bernard),  
Ohio.

Attention: Mr. J. P. Boultiford.

*M18-5*

367/40/15(8-3-NB)

*4/1*

*Z-8-b*

4 - NOV 1936

From: Bureau of Engineering.  
To: Director, Naval Research Laboratory.  
Subject: Radio - Taylor Instrument Co. Thermometers and  
Thermostats, test of. (Bueng Problem M18-5)  
Reference: (a) NRL Report R-1312 (M18-5) dated 29 Sept. 1936.  
(b) Bueng ltr. 367/40/15(8-3-NB) of 5 Aug. 1936,  
to NRL.

1. It is requested that the two thermometers and the two  
thermostats reported upon in reference (a) be returned to the  
Bureau.

2. No further report in the premises will be required, and  
this particular part of the subject problem is hereby closed.

R.J. Ruble,  
By direction.

*MP*

567/40/L5(10-29-38)

Z-G-S-b

1.

*4 - NOV 1936*

Sir:

The two thermometers and the two thermostats (Taylor Instrument Company), discussed in your letter of 27 July 1936, and in the Bureau's letter of 5 August 1936, have been tested by the Naval Research Laboratory, Anacostia, D.C., to determine compliance with Bureau of Engineering specifications RA 13A 4860. The thermometers bear the serial numbers 7A852907 and 7A852912; the thermostats, numbers 7A935962 and 7A935963.

The thermostats were found to comply with the above specifications in all respects. The thermometers conform to specifications in all respects except that the expansion chamber did not protect one of the two instruments at 95 degrees C., and except that the dimensions conform to Naval Research Laboratory drawing RA 40A 2253, a copy of which is enclosed. Both the thermometers and thermostats are considered suitable for Naval use.

It is requested that the information contained herein be divulged only to personnel directly concerned with the procurement or test of the subject instruments; and that steps be taken to prevent the use of any of these data for advertising purposes.

The Bureau will return the four instruments to your office under separate cover. One of the thermometers was somewhat damaged during tests of its expansion chamber.

Very respectfully,

*W. J. Ruble*  
By Director

*R. Alex Martin,*  
Assistant Director of Air Commerce (Air Navigation),  
Department of Commerce,  
Washington, D.C.

REPLY IN DUPLICATE  
AD REFERENCE TO  
**S67/40 M**  
WILL BE APPRECIATED

8

NAVAL RESEARCH LABORATORY  
ANACOSTIA STATION  
WASHINGTON, D.C.

24 October 1934

From: Director.  
To : Inspector of Naval Material, U.S.N.,  
Philadelphia, Penn.  
Subject: Radio - Thermostats for Use in the Naval  
Service - The H-B Instrument Co., Mfr. -  
Navy Type - 40009.  
Reference: (a) I.N.M., Phila.ltr. L4-3/H-B Instrument  
Co., Inc. L4-3/30926 of 22 Oct. 1934.

1. Receipt of reference (a) together with  
Enclosure is acknowledged.

2. The tests of subject thermostats will commence upon receipt of a problem from the Bureau of Engineering authorizing such tests. You are advised that the Laboratory does not forward copies of test reports other than to the Bureau concerned, except when specifically authorized by such Bureau. By copy of this letter the Bureau of Engineering is requested to advise the Laboratory if a copy of the report on tests of subject thermostats should be forwarded to Inspector of Naval Material, Philadelphia.

Copy:  
Bu. Eng.

S67/40 10-24  
OCT 21 1934

R. R. Greenlee.

REPLY IN DUPLICATE  
AND REFERENCE TO

**567/40 M**  
WILL BE APPRECIATED

NAVAL RESEARCH LABORATORY  
ANACOSTIA STATION  
WASHINGTON, D. C.

RDO:LP

12 October 1936

From: Director.  
To: The Chief of the Bureau of Engineering.  
Subject: Radio - Report of Test of Thermometers and  
Thermostats submitted by the Taylor Instru-  
ment Companies. (BuEng. Prob. M18-5)  
Reference: (a) BuEng let. 567/40/L5(8-3-36) of 5 Aug. 1936.  
(b) Bu.Air Comm. (Dept. of Comm.) let. of  
27 July 1936 to BuEng.

1. In accordance with ref.(a), there are being  
forwarded 5 copies of NRL Report No. R-1312, Report of  
Test of Thermometers and Thermostats submitted by the  
Taylor Instrument Companies. These tests were requested  
by the Bureau of Air Commerce.

H. M. Cooley

COPY FOR LT. GOULETT.

J-8-7-h1

567/40/LC (9-11-38)

567/40

1

NAVY DEPARTMENT  
BUREAU OF ENGINEERING  
Washington, D.C.

11 OCT 1935

Gentlemen:

The Bureau forwards herewith one copy of Naval Research Laboratory Report No. R-1192 covering the test of sample thermometers submitted by the Taylor Instrument Companies. This report should not be used for advertising or publicity purposes.

The samples are being returned at your expense.

Your courtesy in submitting such samples to the Navy is appreciated.

Very respectfully,

R. J. Ruble  
By Direction

Taylor Instrument Companies,  
Rochester, New York.  
Attention Mr. Lingg.

Copy to:  
Director, Naval Research Laboratory, Anacostia, D.C.

Copy for "Z" M18-5

S67/40/L5 (6-20-W8)

(J) 8-7-m

8/11/36

14 August, 1936.

14 Aug, '36

From: Bureau of Engineering.  
To: Director, Naval Research Laboratory, Anacostia, D.C.

Subject: Radio - Test of sample thermometers - Bureau of  
Engineering Problem M18-5.

Enclosure: (A) Six sample thermometers. (s.c.)  
(B) Copy of Drawing 8E 40A 133B. (n.w.)

1. Enclosure (A) is forwarded under separate cover  
for examination and test, to determine compliance with Speci-  
fications 8E 13A 136C, except for dimensions which should be  
in accordance with drawing 8E 40A 133B.

2. It is requested that work be prosecuted under Bu-  
reau of Engineering Problem M18-5. A separate report in  
two copies is requested.

J. J. Hubble  
By telephone.

Z

M18-5

867/40/LB(8-3-W6)

Z-J-S-b

J-2-3-L

Out 8-5-34

From: Bureau of Engineering.  
To: Director, Naval Research Laboratory.  
Subject: Radio - Mercury Thermostats and Angle Thermometers  
(Taylor Instrument Co., manufacturer) - (Bueng  
Problem M18-5, Priority "A").  
Reference: (a) Bu. Air Commerce (Dept. of Commerce) ltr. of  
27 July 1936, to Bueng.  
(b) Bueng specifications RG 13A 486B.  
Enclosure: (A) Two (2) Taylor mercury thermostats and two (2)  
Taylor angle thermometers. (s/c)

1. It is requested that enclosure (A) be tested for com-  
pliance with reference (b), and that the Bureau be notified in  
the premises.

P.J. Huble,  
By direction.

367/23/L5 (5-6-#8)

J-8-7-n

(1)  
S.C.

2000-1000

Gentlemen:

The Bureau has examined the relay submitted by your letter of 6 May, 1936, and is returning same under separate cover, since special specifications and procedure have not been adopted for testing relays apart from tests of the complete radio equipment in which incorporated.

Your courtesy in this matter is greatly appreciated.

Very respectfully,

W. J. Ruble  
By direction.

H-B Instrument Company,  
2518 N. Broad Street,  
Philadelphia, Pa.

*M18-5*

COPY.

H-B  
INSTRUMENT COMPANY

2518 N. Broad Street,  
Philadelphia, Pa.

May 6th, 1936.

Navy Department,  
Bureau of Engineering, Radio Section,  
Washington, D.C.

Attn - Comm. Goggins and J. W. Wright.

Gentlemen:

During the writer's recent visit with our Mr. Collins, we mentioned our desire of having our new Relay that has been designed for low current through the coil to operate in conjunction with Navy Radio Type Transmitter Thermostats as listed under Navy Specification RE 13A 486C.

We have about completed our development on this instrument and we are taking the liberty of mailing you one of these, under separate cover, for operation on 110 V. A.C. 60 cycle line voltage. We understand from the coil manufacturer that this is wound according to the latest Navy requirements on coils and impregnated under standard Navy specifications. The Bakelite base is also of the Navy approved type.

The coil current on a straight 110 V. line registers approximately 2 milliamperes and on life test run with standard Navy thermostats, after 5 million make and break impulses, at microscopic examination, we found practically no wear and tear due to the pressure loading of the thermostat and the low current through the coil of the relay.

We would appreciate passing this relay along for standard Navy test and approval, if you have such routine in your Department covering relays. We are anxious to offer these for sale to transmitter manufacturers at the same time we sell our thermostats.

We are standing ready to cooperate in making any modifications necessary in order to bring this under the strict Navy requirements for the particular application outlined above. Thanking you for past courtesies and anticipating the pleasure of a favorable reply, we remain

Very truly yours,  
H-B INSTRUMENT CO. INC.,  
*/s/ Norman McKinney, Sales Manager.*

NICK/GG

Bueng file No.  
S67/23/L5 (5-6)

ONLY IN DUPLICATE  
AS REFERENCE TO  
**EN9/8-2**  
WILL BE APPRECIATED

CJA-ds

M18-5

NAVAL RESEARCH LABORATORY  
ANACOSTIA STATION  
WASHINGTON, D. C.

24 April 1936

*Returned to  
Dept of Air  
Commrce, 1936  
H. M. Cooley*

From: The Director  
To: Bureau of Engineering  
Subject: Radio - Weksler thermal Devices, tests of.  
(Bureau of Engineering Problem M18-5).  
Reference: Bureau Engineering letter ECL7(2-25-W8)  
dated 21 April 1936.  
Inclosure: 1 Weksler thermometer #101 and 1 thermo-  
stat #104.

1. In accordance with reference the above noted  
inclosures are returned herewith.

H. M. Cooley.

(11) 1942

3 December 1934

(14)

NRL Report No. R-1099  
BuEng Proj. M18-5

(12) 48P.

NAVY DEPARTMENT  
BUREAU OF ENGINEERING

Report of

(6)

Tests on Mercury-in-Glass Thermostats,

NAVAL RESEARCH LABORATORY  
ANACOSTIA STATION  
WASHINGTON, D. C.

Number of Pages: Text - 4 Tables 1

Authorization: BuEng Let.S67/40(10-25-W8) of 27 Oct. 1934.

Date of Test: 1 Nov. 1934 to 27 Nov. 1934.

Prepared by:

(10) W. E. Bower  
Asst. Radio Engineer

Reviewed by:

R. B. Owens  
Assoc. Radio Engineer  
Chief of Section

A. H. Taylor  
Physicist  
Superintendent, Radio Division

Approved by:

H. R. Greenlee  
Captain, U.S.N.,  
Director.

Distribution: Bueng (4)  
EPC

## TABLE OF CONTENTS

Authorization of Test	Page 1
Object of Tests	1
Abstract of Tests	1
Conclusions	1a
Recommendations	1b
Key to Manufacturers	1c
Material under Test	2
Method of Tests	2
Data Recorded during Tests	3
Results of Tests	3
Conclusions	4

## APPENDICES

Tabulation of Data on Thermostat Tests

Table I

### AUTHORIZATION

1. This problem was authorized by reference (a), and the governing specifications are listed as reference (b). Reference (c) is a previous report which is pertinent to this problem.

- Reference (a) Bu.Eng. let. S67/40(10-25-W8) of  
27 Oct. 1934.  
(b) Specifications RE 13A 486B.  
(c) N.R.L. Report R-1074 of 21 Sept. 1934.

### OBJECT OF TESTS

2. The object of the tests is to determine if thermostats as supplied by the Collins Instrument Company (types 139-503 and -40008), and the H. B. Instrument Company (type -40009) comply with specifications reference (b), and if they are suitable for Naval use.

### ABSTRACT OF TESTS

3. ✓ The thermostats were tested for accuracy of calibration at the operating temperatures, sensitivity, the effect of shock, accuracy of dimensions, degree of recession of the mercury column at  $-10^{\circ}\text{C}$ , the degree of extension of the column at  $100^{\circ}\text{C}$ , and all other requirements (where possible) under specifications reference (b).

*the appropriate*

CONCLUSIONS

- (a) All of the three samples submitted as Product A passed the tests as outlined in reference (b).
- (b) Two of the three samples submitted as Product B failed in the accuracy of calibration.
- (c) Should the manufacturers of Product B improve the accuracy of calibration, then on the basis of the tests on these samples, same would be suitable for Naval use.

RECOMMENDATIONS

- (a) It is recommended that the H. B. Instrument Company be not granted approval on type No. -40009 because of failures in two of the samples to comply with specifications for operating temperature.
- (b) It is recommended that the Collins Instrument Company be granted approval on both types -40008 and -40004, and also on the diminutive type 139-503 in so far as it passed all requirements of operation but is not listed as for size in reference (b).

Key to Manufacturers.

Product "A" - Collins Instrument Company.

Product "B" - H. B. Instrument Company.

#### MATERIAL UNDER TEST

4. The material under test consists of two mercury-in-glass thermostats of the straight type detailed on page 13B of reference (b) having operating temperatures of 50° C and 60° C, and one of the same type but of diminutive dimensions as follows:

	<u>Length</u>	<u>Width</u>	<u>Diameter</u>
Mercury reservoir or bulb	13/16 inch		1/5 inch
Tip of bulb to first contact ring	2-9/16 inch		
Tip of bulb to second contact ring	3 inch		
Overall dimensions of stem	4-1/4 inch		15/64 inch approx.
Contact rings	1/8 inch	17/64 inch approx.	
Distance between contact rings	9/32 inch		

The operating temperature of this thermostat is 45° C.

The above three thermostats have been referred to as Product A.

5. There are also three mercury-in-glass thermostats of the right angled type detailed on page 14B of reference (b), all having an operating temperature of 50° C. The latter three thermostats have been referred to as Product B.

#### METHOD OF TESTS

6. (a). The operating temperatures and sensitivity were determined by comparison with precision standard thermometers calibrated in hundredths of a degree Centigrade. Each thermometer and thermostat were tightly coupled together in a relatively small beaker into which pure mercury was placed and the bulbs completely immersed therein. The excess of applied heat over and above that necessary to reach the operating point was held to a minimum in each case.

(b). The life test was performed on but five of the six samples submitted as shown in the tabulation of data at the end of this report. The method used was to excite the bulb of the thermostat by heat rays generated by a 500 watt projection lamp. These rays were collected and reflected by a parabolic mirror of medium focal length through a lens system and thence to the thermostat bulb. Interposed between the thermostat and the converging lens was an electro-magnetic light shutter of sufficient aperture to admit the necessary heat rays, the thermostat operating the shutter synchronistically as the thermostat passed through one complete cycle of "on" and "off"

positions, the period of which was governed by the degree to which the bulb was coupled to the focal point of the rays, and the rate of cooling of the bulb during eclipse. The period was held around two to three complete cycles per second although five or six cycles are possible. Over 300,000 complete cycles were recorded for each thermostat tested. One each of the submitted samples was tested at 70 volts R.M.S., 60 cycles and 20 milliamperes as per specifications reference (b), paragraph 4-6. One of Product B and two of Product A units were tested at 12 volts direct potential and 12 milliamperes as per specifications reference (b).

(c). The effect of shock was determined by testing the instruments in a centrifuge.

DATA RECORDED DURING TESTS.

7. The data recorded during tests are shown in Table I.

PROBABLE ERRORS IN RESULTS.

8. The precision thermometers used are of the Beckmann type, and according to the Bureau of Standards calibration are accurate to 0.<sup>0</sup>1C.

9. Errors in the measurement of acceleration by the hand centrifuge are not greater than 10%.

RESULTS OF TESTS.

10. These thermostats were tested and inspected (where possible) to determine compliance with every applicable paragraph of specifications reference (b), with the following exception: Thermostat of type 139-503 No. 2114 operating at 44.<sup>0</sup>94C is not contained in above referred to specification, consequently physical measurements against specifications measurements are not applicable. However, all specifications relating to its operational characteristics were measured in the usual manner, and appear in Table I.

11. From Table I it will be noted that a shifting of the point of operation of the thermostats resulted after 300,000 cycles of test. The direction of shift is, in most cases, to a lower operating temperature except one of Product A, #2039; the mean point of operation of this sample shifted from 59.<sup>0</sup>95C to 61.<sup>0</sup>0C. The on-and-off period of operation showed a period retardation of from 3 to 4 cycles per second to about 0.5 cycle per second, indicating an increase in linear travel of the mercury column before contact was made or broken. One Product B unit #2085 began operating at about 2 to 3 cycles per second on its life test, but considerable trouble was

experienced after a count of 218,000 cycles had been reached due to the mercury running past the last platinum point or operating contact. Its ability to make and break the circuit under this condition gave no little concern, the period being irregular and led to the conclusion that the column had been separated by the presence of mercury or water vapors due to some arcing at the break; assisted possibly by tiny particles of carbon deposit lying between the platinum point and the column. This carbon deposit is now plainly visible together with some condensed mercury which has failed to adhere to the receding column upon **cooling**.

12. An acceleration exceeding those of specifications by 6.4 g were given two samples of Product A, Nos. 2038 and 2039, No. 2039 separated while No. 2038 remained intact. No. 2039 was accidentally broken in an effort to reunite the column. Both Nos. 2038 and 2039 had previously successfully withstood the acceleration test of 50g in accordance with specifications.

13. Two thermostats of Product B, Nos. 2083 and 2085, failed the subject tests of paragraph 4-3, of specifications, reference (b), by 0.<sup>0</sup>01 C and 0.<sup>0</sup>03 C, respectively.

#### CONCLUSIONS

14. All of the three samples submitted as Product A passed the tests as outlined in reference (b).

15. Two of the three samples submitted as Product B failed in the accuracy of calibration.

16. Should the manufacturers of Product B improve the accuracy of calibration, then on the basis of the tests on these samples, same would be suitable for Naval use.

**TABLE I**  
**TABULATION OF DATA ON THERMOSTAT TESTS**

Make	No.	Initial Operating Temperature	Initial Sensitivity	Life test*	Final Sensitivity	Operating Temperature	Source	Frequency of Operation
Product A	2038	49.°96C	0.°01C	304,000	0.°01C	49.°89C	A.C.	2-3 cycles/sec
Product A	2039	59.°95C	0.°004C	314,566	-	61.0 C	D.C.	3-4 cycles/sec
Product A	2114	44.°94C	0.°01C	400,000	0.°002C	44.°92	D.C.	.5 cycles/sec
Product B	2083	49.°93C	0.°002C	306,125	0.°009C	49.°91C	D.C.	4-5 cycles/sec
Product B	2085	49.°91C	0.°002C	309,000	0.°006C	49.°90C	D.C.	4-5 cycles/sec
Product B	2093	49.°94C	0.°02C	-	-	-	A.C.	2-3 cycles/sec
* Note: Test discontinued, maximum life not indicated.								
Make	No.	Recession at - 10°C	Expansion at 100°C	Centrifuge	Centrifuge	Satisfactory	Remarks	
Product A	2038	0.87 in. #	at 100°C	at 100°C	at 100°C	"	Mercury capillary tube appears clean - operation good.	
Product A	2039	0.31 in.	"	"	"	"	Capillary clean - operation good up to 303,526 afterward was sluggish.	
Product A	2114	1.06 in.	"	"	"	"	Capillary clean - operation good.	
Product B	2083	1.73 in.	"	"	"	"	Capillary blackened - Residual globules of mercury around contact point.	
Product B	2085	1.77 in.	"	"	"	"	Capillary clean but carbon deposit on upper contact.	
Product B	2093	1.18 in.	"	"	"	"	Life test omitted - Capillary clean - contact clean.	

# Figures indicate height above mercury reservoir.

# Figures indicate height above mercury reservoir.